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Foraging Preferences of Captive Canada Geese Between Tall Fescue and Perennial Ryegrass Mixtures for Airfields

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16. Abstract

Wildlife strikes to the civil aviation industry in the United States, which generally are caused by birds in the airport environment, are both costly and deadly. Habitat management techniques that reduce bird use of habitats on and around airports are therefore critical for safe airport operations. This study was conducted during 2000-2003 at NASA Plum Brook Station in Erie County, Ohio to determine if Canada geese (*Branta canadensis*) exhibited a feeding preference between an endophyte-infected tall fescue (*Festuca arundinacea*) and a perennial ryegrass (*Lolium perenne*) mixture. The behavioral responses of captive geese to the two vegetation types were observed during July and August of the first (2001) and third (2003) growing seasons following seeding of grass mixtures in the spring of 2000. During 2001, Canada geese showed no preference between the tall fescue and perennial ryegrass mixture plots when loafing, resting, or foraging. However, after two additional growing seasons, the tall fescue became the dominant plant in the fescue treatment plots (91% coverage) and formed a dense monoculture. During behavioral observations conducted in 2003, Canada geese fed almost exclusively in the perennial ryegrass mixture plots and avoided foraging in the tall fescue plots. The findings from this study suggest endophyte-infected tall fescue might be a favorable species to be used in reseeding and vegetation renovation projects on airfields and other areas where Canada geese are a potential problem. We recommend that field trials with candidate high endophyte tall fescue varieties be conducted on airports in various parts of the United States to determine in which geographical regions specific varieties will from dense monocultures.

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EXECUTIVE SUMMARY

Wildlife strikes to the civil aviation industry in the United States, which generally are caused by birds in the airport environment, are both costly and deadly. Habitat management techniques that reduce bird use of habitats on and around airports are therefore critical for safe airport operations. The objective of this study was to determine if captive Canada geese (*Branta canadensis*) exhibited a foraging preference between an endophyte-infected tall fescue (*Festuca arundinacea*)-based vegetation mixture and a vegetation mixture consisting mostly of perennial ryegrass (*Lolium perenne*) and white clover (*Trifolium repens*). We established 6 paired plots of tall fescue-dominated and perennial ryegrass-dominated seed mixtures at NASA Plum Brook Station in northcentral Ohio during 2000. Behavioral observations of captive Canada geese were conducted one (2001) and three (2003) growing seasons after the seed mixtures were planted.

During 2001, the numbers of geese observed in tall fescue plots ($\bar{x}$ = 1.9 geese/plot, SE = 0.33) and ryegrass plots ($\bar{x}$ = 2.0 geese/plot, SE = 0.35) were not different ($F_{1,10}$ = 0.03, P = 0.86). Foraging by captive Canada geese was similar ($F_{1,10}$ = 0.26, P = 0.62) in the perennial ryegrass plots ($\bar{x}$ = 12.8 bill contacts per minute/4 geese, SE = 1.37) and the tall fescue plots ($\bar{x}$ = 11.2 bill contacts per minute/4 geese, SE = 2.86). During the next two growing seasons, tall fescue coverage increased to 91% and this grass formed a dense monoculture in the tall fescue plots. White clover decreased, whereas perennial ryegrass and other plants increased, in the perennial ryegrass plots during the same time period. During 2003, the number of captive geese observed in ryegrass plots ($\bar{x}$ = 3.0 geese/plot, SE = 0.19) was three times higher ($F_{1,10}$ = 56.86, $P \leq 0.001$) than in the fescue plots ($\bar{x}$ = 1.0 geese/plot, SE = 0.19). Geese foraged almost exclusively in the perennial ryegrass plots ($\bar{x}$ = 30.7 bill contacts per minute/4 geese, SE = 1.55) and avoided foraging ($F_{1,10}$ = 346.54, $P \leq 0.001$) in the tall fescue plots ($\bar{x}$ = 0.8 bill contacts per minute/4 geese, SE = 0.41) during 2003.

The findings from this study suggest tall fescue might be a favorable species to be used in reseeding and vegetation renovation projects on airfields and other areas where Canada geese are a potential problem. We recommend that field trials with high endophyte tall fescue varieties be conducted on airports in various parts of the United States to determine in which geographical regions specific varieties will form dense monocultures.

1. INTRODUCTION.

Bird-aircraft collisions (bird strikes) cause serious safety hazards to aircraft and their occupants. During the 1990s, bird strikes cost civil aviation at approximately $500 million annually in the United States (Cleary et al. 2005). Gulls (*Larus* spp.), waterfowl such as Canada geese (*Branta canadensis*), raptors (hawks and owls), and blackbirds (Icterinae)/starlings (*Sturnus vulgaris*) are the species presently of most concern at airports (Cleary et al. 2005, Dolbeer et al. 2000). Most strikes occur under 1000 feet altitude (above ground level) in the vicinity of the airport (Cleary et al. 2005). Wildlife management techniques that reduce the number of birds in and around airports are therefore critical for safe airport operations.

Habitat management is a long-term component of an integrated approach for reducing bird use of airports. One method suggested to reduce bird numbers on airports is to manage vegetation height. The basis for these recommendations comes from studies conducted in Great Britain (Brough 1971, Mead and Carter 1973, Brough and Bridgman 1980), in which bird species of concern in the United States were not present. Preliminary studies to determine if tall grass reduces bird activity at airports in the United States have produced conflicting results (Buckley and McCarthy 1994, Seamans and Dolbeer 1998, Barras et al. 2000, Seamans et al. 2002).

Species composition of airfield vegetation can also affect the relative attractiveness of these areas for birds and small mammals (Austin-Smith and Lewis 1969, Brooks et al. 1976, Smith 1976, Dekker and van der Zee 1996). On tropical airfields, *Wedelia* sp. was found to be unattractive to birds and small mammals (Linnell et al. 1995). Tall fescue (*Festuca arundinacea*), a sod-forming cool-season grass of temperate environments, might also be unattractive to wildlife. In fact, many varieties of this plant are infested with an endophytic fungus *Neotyphodium coenophialum* and thus might be repellent to small mammals (Pelton et al. 1991, Coley et al. 1995, Conover 1998) and birds (Conover 1991, Conover and Messmer 1996) following repeated consumption. Tall fescue is also deep-rooted and drought resistant, which might be advantageous for airport vegetation where soils are typically poor.

Our objective was to determine if Canada geese exhibit a foraging preference when given a choice between an endophyte-infected tall fescue-dominated plant mixture and a perennial ryegrass-dominated plant mixture. We presented captive Canada geese with plots of vegetation resulting from two seed mixtures [one containing primarily tall fescue and the other containing primarily perennial ryegrass (*Lolium perenne*) and white clover (*Trifolium repens*)] in northcentral Ohio to determine if they demonstrated a preference for either vegetation type.

2. METHODS.

The study was conducted from May 2000 through October 2003 at the National Aeronautics and Space Administration's Plum Brook Station (PBS), Erie County, Ohio (41°37′N, 82°66′W). The 2,200-ha facility is enclosed by a 2.4-m high chain-link fence with barbed-wire outriggers. Existing goose holding facilities adjacent to grasslands facilitated the establishment of plots for

experiments on behavioral response of captive birds to different vegetative mixtures without the disturbances characteristic of airfields.

The study design followed that of Dolbeer et al. (1998). We established 6 experimental arenas (18.3 X 31.5 m). Each arena was divided into 2 18.3- x 15.2-m plots. One of 2 plant mixes (ryegrass or fescue) was assigned to each plot within an arena prior to plot construction. The seed mixture planted in ryegrass plots consisted of a mixture of perennial ryegrass (40%), creeping red fescue (*Festuca rubra*, 40%), white clover (10%), and highland bentgrass (*Agrostis capillaris*, 10%). This seed mixture is the standard mix used by the Washington State Department of Transportation for erosion control. The fescue plots were seeded with an experimental mixture dominated by Crossfire II® tall fescue (95%), a high-endophyte turf-type tall fescue variety, and subterranean clover (*Trifolium subterraneum*, 5%). Ryegrass and fescue seed mixtures were seeded into the appropriate plots in May of 2000. Vegetation in control and treatment plots was allowed to establish for a 13-month period prior to the start of experiments with captive Canada geese.

Grass height was managed by mowing the ryegrass and fescue plots to a height of 15-20 cm prior to the start of the experiment. A 1.5-m black plastic fence was erected around the 6 experimental arenas. A 0.5-m diameter pan of water was placed in the center of each ryegrass and fescue plot. Four geese were herded to each of the 6 arenas daily at 0830 hr and allowed to graze on ryegrass and fescue plots until 1200 hr, when they were returned to their holding pen. All geese were fitted with a unique color-coded neck band to ensure that the same individuals were placed into the same pen each day.

Behavioral observations of captive Canada geese were conducted for 18 days during 11 July – 20 August 2001. Three observers stationed on 4.9–m towers 20 m from the arenas monitored goose activity. Observations were made for 2 1-hour periods (0.5 and 2.5 hrs after geese were herded into arenas) on 3 days per week for 6 weeks. Each observer watched 2 arenas, alternating observations of each arena every minute. At the start of each minute, observers recorded the initial number of geese in each plot (ryegrass and fescue) and then for the following 30-seconds counted the number of bill contacts with grass of all geese in each plot.

Behavioral observations of captive Canada geese were again conducted for 15 days during 15 July –14 August 2003. Observational methods in 2003 were the same as to those used in 2001.

We independently analyzed Canada goose behavioral data from 2001 and 2003. We compared the number of geese in plots and the number of bill contacts by geese using repeated measures analysis of variance (Crowder and Hand 1990). We considered differences significant at $P \leq 0.05$ and conducted all analyses using SAS 9.1 (SAS Institute 1990).

Plant communities in the control and treatment plots were monitored weekly from 26 July – 24 August 2001. Three sample points were randomly selected in each ryegrass and fescue plot. At each sample point, the maximum vegetation height was measured by vertically placing 2 1-meter sticks 1.5 m apart with a string attached to the sticks. The height of the string was adjusted horizontally to the top of the tallest plant under the string and the distance of the string

to the ground was recorded. Plant community composition was sampled at 6 set points along the 1.5-m string used to measure vegetation height. The plant species immediately below each sample point was identified and recorded.

Plant communities in the ryegrass and fescue plots were monitored weekly from 17 July – 28 August 2003. Vegetation measurements in 2003 were conducted using the same methods as during 2001.

The maximum height of vegetation (cm) in the fescue and ryegrass plots was compared using paired t-tests (SAS Institute 1990). We compared the coverage of tall fescue, perennial ryegrass, and white clover during 2001 and 2003 using comparison of proportion tests (SAS Institute 1990). We considered differences significant at $P \leq 0.05$ and conducted all analyses using SAS 9.1 (SAS Institute 1990).

3. RESULTS.

During 2001, The numbers of geese observed in fescue plots ($\bar{x}$ = 1.9 geese/plot, SE = 0.33) did not differ ($F_{1,10}$ = 0.03, P = 0.86) from that of perennial ryegrass plots ($\bar{x}$ = 2.0 geese/plot, SE = 0.35). The number of bill contacts by geese in tall fescue plots ($\bar{x}$ = 11.2 bill contacts per minute/4 geese, SE = 2.86) was similar ($F_{1,10}$ = 0.26, P = 0.62) to the number of bill contacts by geese in the perennial ryegrass plots ($\bar{x}$ = 12.8 bill contacts per minute/4 geese, SE = 1.37) during 2001. Overall, there was no temporal pattern in use of ryegrass or fescue plot vegetation demonstrated by number of geese observed in plots (figure 3-1) or the number of bill contacts by geese (figure 3-2).

During 2003, the number of captive geese observed in ryegrass plots ($\bar{x}$ = 3.0 geese/plot, SE = 0.19) was three times higher ($F_{1,10}$ = 56.86, $P \leq 0.001$) than in the fescue plots ($\bar{x}$ = 1.0 geese/plot, SE = 0.19). The number of bill contacts by geese in the perennial ryegrass plots ($\bar{x}$ = 30.7 bill contacts per minute/4 geese, SE = 1.55) was 38 times higher ($F_{1,10}$ = 346.54, $P \leq 0.001$) than the number of bill contacts by geese in the tall fescue plots ($\bar{x}$ = 0.8 bill contacts per minute/4 geese, SE = 0.41). In 2003, foraging captive Canada geese exhibited a clear preference for the vegetation in the ryegrass plots as demonstrated by both the number of geese observed in plots (figure 3-3) and the number of bill contacts (figure 3-4) on all 15 observation days.

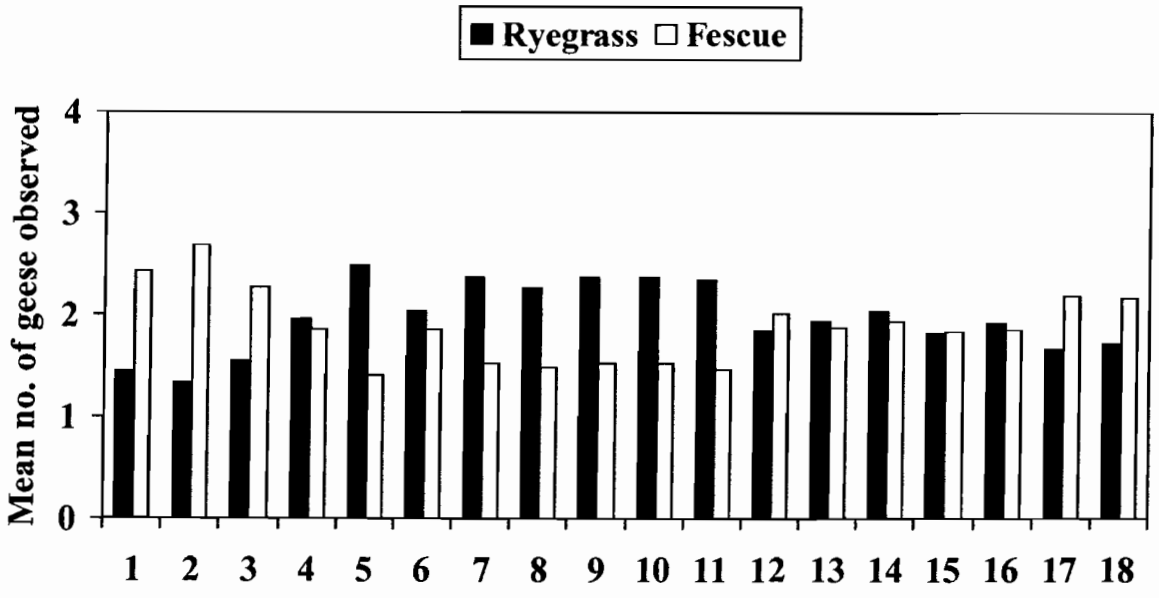

FIGURE 3-1. MEAN NUMBER OF CAPTIVE CANADA GEESE OBSERVED (6300 TOTAL COUNTS) IN 6 PAIRED PLOTS OF VEGETATION DOMINATED BY TALL FESCUE OR A PERENNIAL RYEGRASS-BASED MIXTURE AT NASA PLUM BROOK STATION, OHIO, 11 JULY-20 AUGUST, 2001

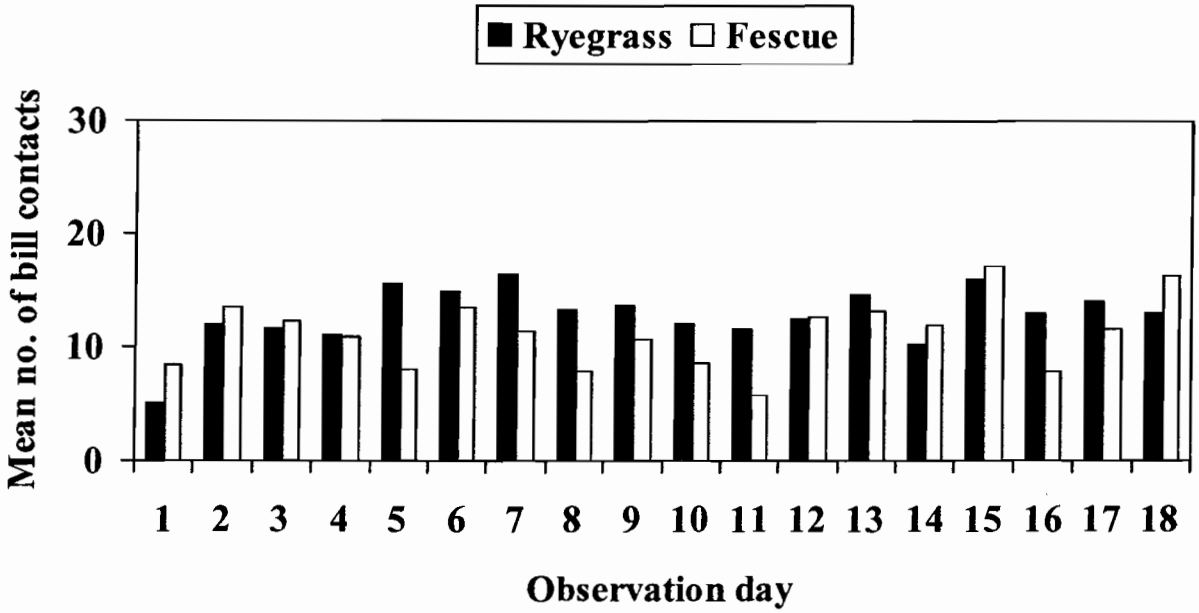

FIGURE 3-2. MEAN NUMBER OF BILL CONTACTS PER MINUTE BY CAPTIVE CANADA GEESE (6300 TOTAL COUNTS) IN 6 PAIRED PLOTS OF VEGETATION DOMINATED BY TALL FESCUE OR A PERENNIAL RYEGRASS-BASED MIXTURE AT NASA PLUM BROOK STATION, OHIO, 11 JULY-20 AUGUST, 2001

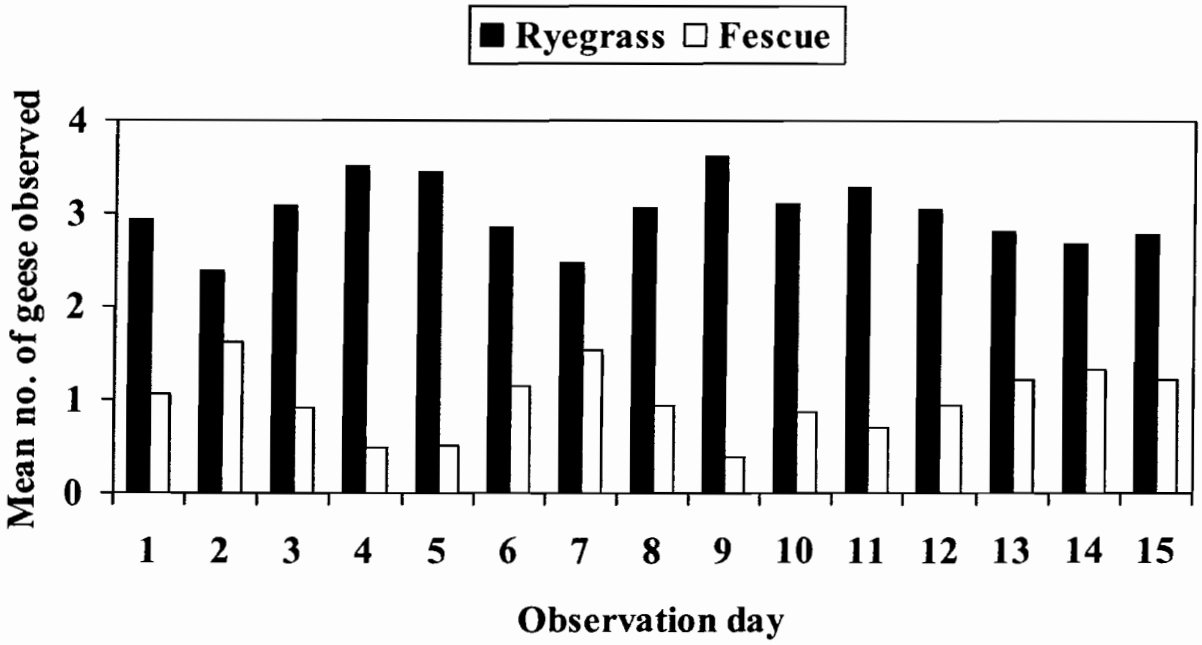

FIGURE 3-3. MEAN NUMBER OF CAPTIVE CANADA GEESE OBSERVED (5400 TOTAL COUNTS) IN 6 PAIRED PLOTS OF VEGETATION DOMINATED BY TALL FESCUE OR A PERENNIAL RYEGRASS-BASED MIXTURE AT NASA PLUM BROOK STATION, OHIO, 15 JULY-14 AUGUST, 2003

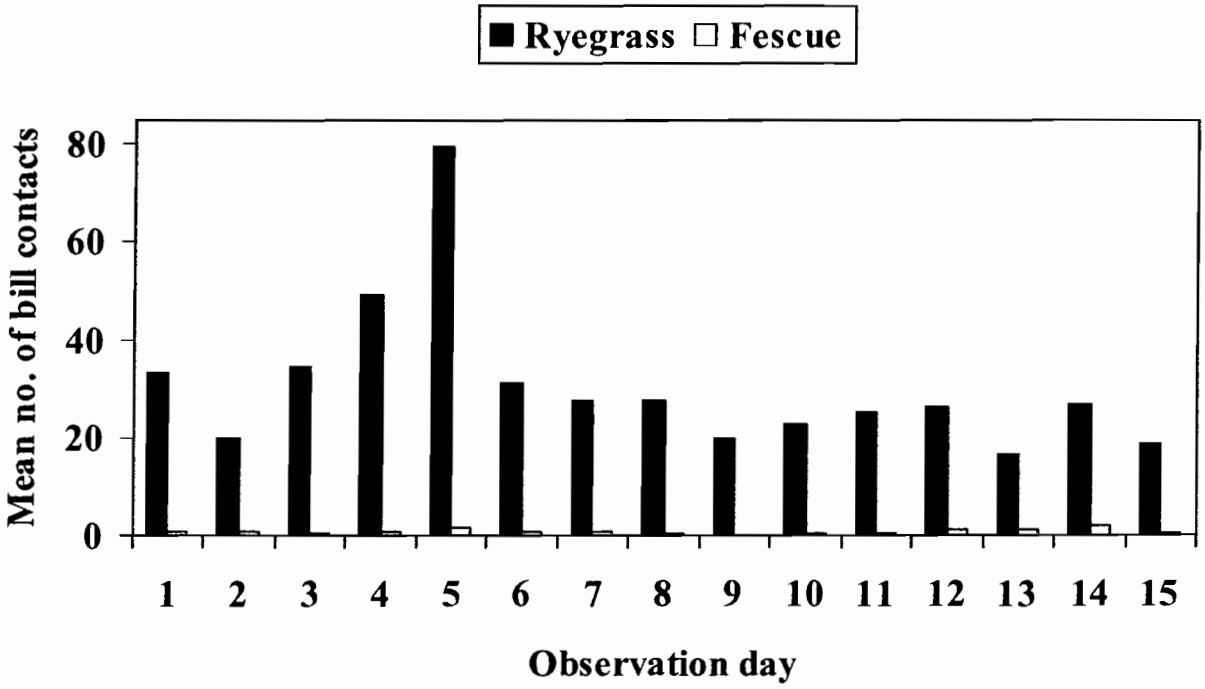

FIGURE 3-4. MEAN NUMBER OF BILL CONTACTS PER MINUTE BY CAPTIVE CANADA GEESE (5400 TOTAL COUNTS) IN 6 PAIRED PLOTS OF VEGETATION DOMINATED BY TALL FESCUE OR A PERENNIAL RYEGRASS-BASED MIXTURE AT NASA PLUM BROOK STATION, OHIO, 15 JULY-14 AUGUST, 2003

Mean maximum vegetation height in the ryegrass plots ($\bar{x}$ = 9.9 cm, SE = 0.28) was lower (t_{178} = 2.34, P = 0.02) than in the fescue plots ($\bar{x}$ = 11.0 cm, SE = 0.33) during 2001. Plant communities in the ryegrass plots were dominated by white clover (94% coverage), with small amounts of perennial ryegrass and other plants (figure 3-5). Plant communities in the fescue plots had large amounts of tall fescue (72% coverage), slight amounts of subterranean clover, and 23% coverage by other plants (e.g., plantain, hairy crabgrass; figure 3-5).

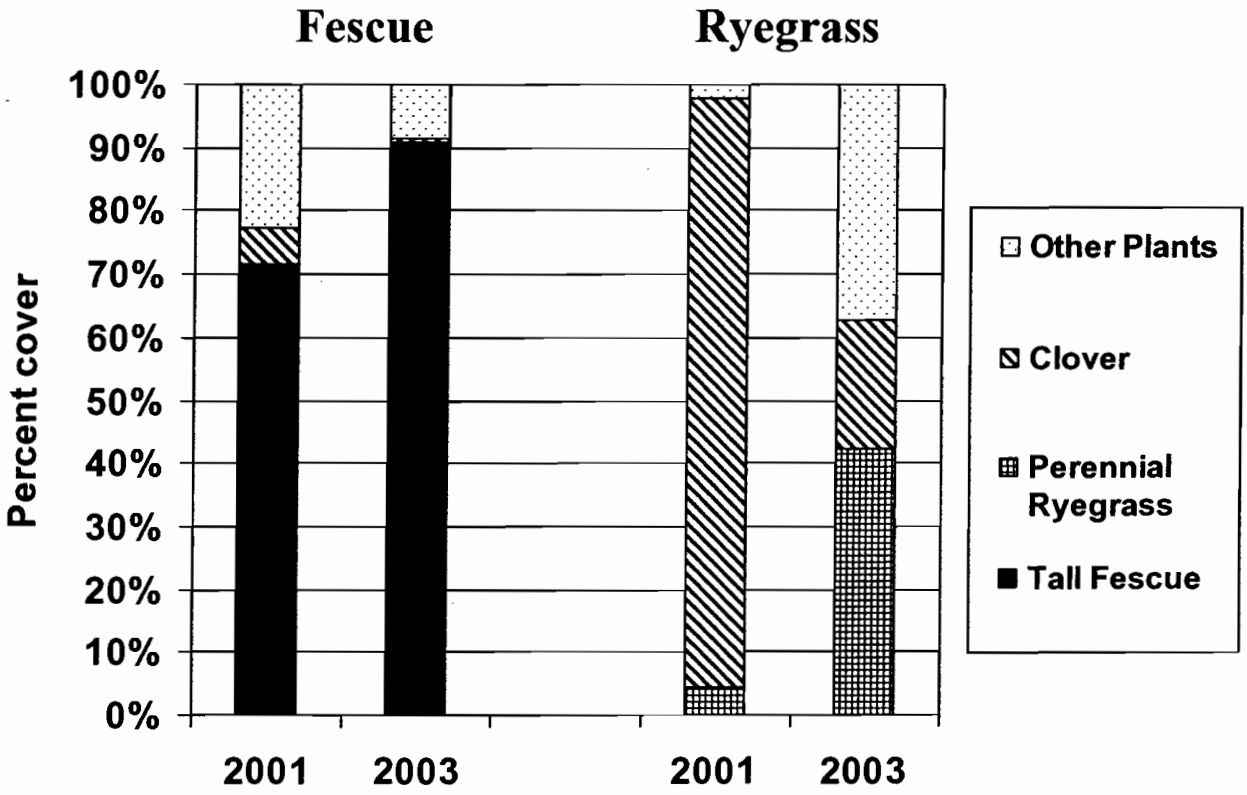

FIGURE 3-5. PERCENT CANOPY COVERAGE OF TALL FESCUE, PERENNIAL RYEGRASS, CLOVERS, AND OTHER PLANT SPECIES IN 6 PAIRED PLOTS OF VEGETATION DOMINATED BY TALL FESCUE OR A PERENNIAL RYEGRASS-BASED MIXTURE AT NASA PLUM BROOK STATION, OHIO, JULY-AUGUST, 2001 AND JULY-AUGUST, 2003

During 2003, mean maximum vegetation height in the ryegrass plots ($\bar{x}$ = 18.6 cm, SE = 0.65) was lower (t_{214} = 2.34, P = 0.02) than in the fescue plots ($\bar{x}$ = 20.3 cm, SE = 0.53). Plant communities in the ryegrass plots consisted of more perennial ryegrass (Z = 6.22, $P \leq 0.001$), much less white clover (Z = 10.43, $P \leq 0.001$), and 35% more coverage of other plants (Z = 6.19, $P \leq 0.001$) compared to plant communities in 2001 (figure 3-5). Tall fescue coverage increased (Z = 3.28, $P \leq 0.001$) by about 20% in the fescue plots from the first growing season (2001) to the third growing season. Tall fescue dominated (91% coverage) the fescue plots; small amounts of other plants and subterranean clover were present as well (figure 3-5).

4. DISCUSSION.

During the first growing season after planting, Canada geese spent time and foraged in both the endophyte-infected tall fescue and the perennial ryegrass plots. In addition to foraging, time in each plot might be spent loafing or in other non-feeding behaviors (Belant et al. 1997). Given the dominance of white clover in the perennial ryegrass plots, geese were likely foraging on that species when feeding in those plots. White clover is a preferred forage of brent geese (*Branta bernicla*; McKay et al. 2001) and greater snow geese (*Chen caerulescens*; Gauthier and Bedard 1991) and thus might be favored by Canada geese due to its high protein content and lower fiber content (Ball et al. 1991). Although Canada geese foraging in the tall fescue plots might have been feeding on tall fescue, it is more likely they were selecting for subterranean clover or other non-fescue plants. Washburn (2000) found that wild eastern cottontail rabbits (*Sylvilagus floridanus*) selectively avoided foraging on tall fescue in grasslands that consisted primarily (approximately 95% coverage) of this grass.

Plant community composition changed in both the fescue and ryegrass plots between the end of the first and the start of the third growing season after planting. Tall fescue is extremely competitive and develops into solid stands, crowding out other grasses, legumes, and annual weeds (Barnes et al. 1995, Washburn et al. 2000). In this study, tall fescue formed a dense monoculture, increasing from approximately 70% initially to over 90% by the third growing season. In the perennial ryegrass plots, coverage of white clover decreased by approximately 75% from the first to the third growing season, while the amount of perennial ryegrass and other plants increased during the same time period.

During the third growing season after planting, Canada geese exhibited a strong feeding preference for the vegetation resulting from the perennial ryegrass and white clover seed mixture compared to the tall fescue-dominated seed mixture. Canada geese spent approximately 75% of their time in the perennial ryegrass and clover plots and foraged almost exclusively in those plots. Geese were likely foraging on perennial ryegrass, white clover, or other plants (e.g., crabgrass) in the ryegrass plots. Conversely, geese did not forage in the tall fescue plots. Conover (1991) also reported that Canada geese preferred to forage on perennial ryegrass compared to tall fescue. The increase in tall fescue coverage (from 70% to 90%) and concurrent reduction in white clover might explain part of the change in feeding behavior by the geese in this study.

Canada geese likely avoided foraging on tall fescue grass during this study because of the presence of the tall fescue endophyte, a naturally occurring fungus that forms a symbiotic relationship with the grass. Endophyte-infected tall fescue produces a variety of secondary plant defense compounds (e.g., alkaloids) that have been shown to cause weight loss, reproductive problems, and a variety of diseases in livestock and laboratory small mammals (Schmidt and Osborn 1993, Bacon and Hill 1997). Recent studies suggest wild mammals and birds might be adversely affected by consumption of endophyte-infected tall fescue (Madej and Clay 1991, Pelton et al. 1991, Coley et al. 1995, Lane 1995). Alkaloids produced by endophyte-infected tall fescue act as a feeding deterrent (e.g., taste aversion) and result in post-ingestion distress in animals that consume the plant (Aldrich et al. 1993, Bacon and Hill 1997). Conover and Messmer (1996) reported captive Canada geese preferred to graze on non-infected tall fescue

compared to endophyte-infected tall fescue, and that geese foraging on endophyte-infected tall fescue lost body mass.

Recently, a large number of "turf-type" tall fescue varieties have been developed for lawns, golf courses, parks, and other traditional turfgrass uses. Turf-type tall fescue varieties are bred for horticultural characteristics important to the turfgrass industry (e.g., deep green color, drought and disease resistance, and growth to shorter heights than traditional tall fescues). In addition, many of these new varieties have high levels of endophyte infection (Mohr et al. 2002).

The findings from this study suggest endophyte-infected tall fescues might be favorable turfgrass varieties to use in reseeding and vegetation renovation projects on airfields and other areas where Canada geese are unwanted. We recommend that field trials be conducted on airports in various parts of the United States to determine which high endophyte tall fescue varieties might be useful in different physiographic regions of North America.

In addition to endophyte-infected tall fescue, other plants have shown promise as desirable airport vegetation that is unattractive to wildlife. On tropical airfields, *Wedelia* sp. was found to be unattractive to birds and small mammals (Linnell et al. 1995). Pochop et al. (1999) found three species of native Alaskan plants that were not preferred by Canada geese and could feasibly be planted on airfields.

Many questions remain unanswered regarding which specific vegetation types and species are most appropriate, as well as specifically where on airfields they should be planted, to minimize the attractiveness of airports to hazardous wildlife. Much future research will be required to find those plants that will meet the needs of ground cover without attracting wildlife hazardous to aviation in all of the various ecotypes found across the United States.

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